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ABSTRACT

Internetworked communications restructures relationships among educators, learners, and knowledge and information, and promises a systemic acceleration of the pace of educational change. In this report, the Task Force on Education Network Technology identifies the following rationales for deployment and utilization of such communications: to support and accelerate systemic change for educational excellence; to reconstruct and improve teaching; to expand and enrich learning opportunities; and to link schools and society to improve economic productivity and encourage lifelong learning. The problems in deployment and utilization identified are schools' organizational resistance to change and lack of technology systems support; inadequate teacher preparation and insufficient support for new modes of instruction; narrow and outmoded instructional practices and limited access to knowledge and information; and schools' disconnection from the larger society and inexperience with advanced technology resources. Finally, recommendations for deployment and utilization are listed: to invest in the appropriate system infrastructure for real educational reform and restructuring; to provide extensive professional development to maximize the likelihood of robust changes in curriculum and instruction; to expand available learning resources and enrich opportunities for access to knowledge; and to forge strategic connections surrounding schools to support the achievement of the national education goals. (JLB)

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ED 368 351

NATIONAL EDUCATION GOALS PANEL

ACHIEVING EDUCATIONAL EXCELLENCE BY INCREASING ACCESS TO KNOWLEDGE:

DISCUSSION DOCUMENT

Report to the
National Education Goals Panel

TASK FORCE ON EDUCATION
NETWORK TECHNOLOGY

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July 27, 1993

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Achieving Educational Excellence by Increasing
Access to Knowledge

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ABSTRACT

Education mirrors our society, and ought to move us forward.

But schools today do not reflect the changing American economy -- schooling is still organized and conducted for an outmoded industrial order. Our emerging Information Society requires new forms of information processing and knowledge production to shape our shared future. To prepare for the society we desire, we need knowledge workers who can access, analyze, and integrate information, and generate new knowledge in interactive environments. American education must ensure our nation's economic vitality, and prepare our people for full participation in a modern democracy.

It has been nearly four years since the Education Summit in Charlottesville that specified our country's commitment to reforming schools. We have just six years left until the end of the century, when we have pledged to achieve the Goals. We need systemic strategies for system change. Internetworked computing and communications -- appropriately deployed and integrated in education -- is a comprehensive, cost-effective, equitable, and educationally compelling mechanism for helping us meet our national Goals for educational excellence.

For purposes of this report, network technology is a set of tools and services that enables educators, students, and the public to use computer and telecommunication links to share and access information and other resources to achieve systemic reform in education.

- Internetworked communications restructures relationships among educators, learners, and knowledge and information, and promises a systemic acceleration of the pace of educational change.

- For teachers, it means: 1) the chance to develop a professional community with other educators; 2) technical assistance in achieving a standards-based curriculum; and 3) an expansion of their pedagogical repertoires to serve students' diverse learning styles.

- For students, it means: 1) more learning resources, more readily available; 2) information on-demand and immediate feedback; and 3) a context for learning that both engages and empowers them.

- For the larger society, it means: 1) home and workplace connections with schools; 2) learning-for-life; 3) technological literacy for economic progress, and 4) the communication and exchange essential to democratic living.

March, 1993

Convening of a Technical Planning Subgroup on Education Network Technology

Charge:

To create and report on a vision on the use of network technology to help the nation and states achieve the National Education Goals. In particular, the group will:

- Investigate how education network technology can be used to enhance classroom learning and teaching, as well as facilitate the processing, sharing and analyzing of information from school record systems;
- Develop a core set of principles for the creation and implementation of network technology systems in education;
- Determine how educational network technology needs should be coordinated with the development of a National Information Highway system;
- Investigate whether it is desirable and feasible to develop a set of voluntary national standards to guide the creation of education technology networks nationwide.

The Context of Change and the Promise of Education Network Technology

Our Concern About Changing Schools

Our initial Task Force response to our charge was a sense of urgency. It has been ten years since release of the "Nation at Risk" report, nearly four years since the Charlottesville summit that sparked development of our national Goals for education. We have less than six years until the turn of the century when we have committed ourselves to have changed education in some specific and substantive ways.

The early attention to education reform in the mid-eighties focused mainly on an excellence agenda of higher expectations and performance. The so-called second wave, more recently, has emphasized the necessity of restructuring schools to meet the needs of modern America. Enlightened educators and public decisionmakers know we must replace the outmoded forms of American schooling to secure our nation's social and economic future. Less than three percent of our people are actively engaged in agriculture, yet we maintain an agrarian clock and calendar for schooling, left over from the days when we needed our children to help with harvests and the late afternoon chores of farm life. Less than eleven percent of our population is employed in industry, but our schools are still organized like factories, focused on discrete tasks and narrow notions of achievement.

We have come to understand, as a nation, that an industrial model of school organization is insufficient for an information society; that productive workers need new knowledge and skills and the ability to work together in new ways; that the lock-step learning of the past is not useful for the knowledge workers of our future. We are rethinking roles and relationships inside schools, building collaboration, creating opportunities for new patterns of engagement, constructing more thoughtful and more meaningful learning activity.

The Goals Panel's concerns with standards embodies the public interest in education that is not just good-enough, but better-than-ever -- for everyone. New standards by which to judge educational excellence and new tools for measuring achievement indicate our commitment to higher order thinking, more robust and demanding educational activity, and a thoughtful focus on quality in every dimension of schooling.

Standards-setting is an extremely important step in articulating what we mean by excellence and how we are going to measure achievement. Unfortunately, it is not enough simply to set standards, we must also make sure we meet them.

Despite all the rhetoric and work of the past ten years, what Ted Sizer, Chairman of the Coalition of Essential Schools, terms this "surge" of reform across the country, the pace of change has been disturbingly slow. Even in the tight time frame we have adopted to achieve our Goals for educational excellence, a statistical generation of students is passing through our schools largely untouched by our commitments to change, and unaffected by our new standards of achievement. Most adults in our society cannot imagine an education different from what they have experienced. Teachers are not being adequately taught or re-trained in new ways to bring about fundamental changes in teaching and learning. And schools, overall, are resistant to really reorganizing their customary processes and practices.

Our Commitment to Strategic Action

We believe we need new mechanisms to help school districts decentralize decisionmaking and develop appropriate forms of accountability, to facilitate teacher-to-teacher communications of ideas and information, to enable students to explore more vital knowledge in more meaningful ways. We have taken our task force charge as a strategic challenge: to think about how to use network technology to realize the Goals as quickly and effectively as possible.

The discussion documents for the regional forums on the national Goals repeatedly speak to the need to use technology to improve teaching and learning, amplify existing resources, and connect school to work.

Many educators are now well-along in making use of available technologies to enrich classroom instruction and make learning more vivid and engaging. Video discs and snap cameras, hypercard stacks, laser printers, and VCRs are already irrevocably changing our conceptions of how to prepare and present material for study in classrooms across our country. Properly left to local discretion -- teacher interest and community investment -- they can continue to amplify the work of imaginative educators and engage students more meaningfully. But, functionally separate, they hold little promise for sustained, systemic change.

Of all the useful and promising technologies available to educators today, we think one stands out as particularly potent and uniquely valuable for assisting in the achievement of our national goals. We have particularized our task force attention to network technology because we think most educational reform, like most instructional enrichment, is isolated and idiosyncratic. The magnitude of the problem of re-forming American education is so great that we believe we need systemic support for significant system change.

Internetworked communications and access to information is a rich curricular resource and an invitation to inquiry and exchange. This medium offers a dramatically decentralized and essentially democratic learning environment. Abundant resources available on-line suggest new ways of accessing information, generating and disseminating knowledge, working independently and collaboratively, (unbounded by the physical limitations of place and time, or the personal characteristics of participants). Pervasive, real-time communication creates a new context for thinking and interacting and presents unprecedented pedagogic opportunities for exchanging ideas and information and creating "virtual" labs and classrooms and enriched teaching and learning.

Only comprehensive technologic support of this kind can help us make necessary progress in achieving the Goals we have set ourselves. In describing network technology's value for reshaping American education, however, we must distinguish between vain efforts to build The One Best System, and systemic supports for realizing the best of all possible educations. Unilateral prescriptions are unfortunate and ill-conceived; we have learned in the last decade that we cannot mandate authentic change or require fundamental reform. Instead, we need to appreciate the dimensions and demands of the Information Age in which we live and work, and make sure that requisite knowledge and information are readily available to teachers and students. We will have to educate educators and the public to the lack of structure in pervasive communication, and the virtual permeability of what have seemed to be barriers separating domains of knowledge, segmenting educational experience, and creating an unfortunate chasm between the worlds of elementary and secondary schooling and post-secondary and post-graduate research.

The pre-K/12 community must be awakened to the enriched educational opportunities afforded by internetworked communications and information access, and be open to the challenge and possibilities of this emerging technology frontier. The commitment to educational excellence embodied in the Goals, and related standards and assessments, requires a strategic response of a magnitude unmatched since, as a country, we began allocating land for schools. We no longer need land grants; but we do need this new information infrastructure to enable educators to effect the achievement we expect.

As a senator, Vice-President Gore was prime sponsor for P.L. 102-194, the National Research and Education Network (NREN), signed into law by former President Bush in December, 1991. The NREN commits our country to connect all educational institutions, research centers and libraries in a high performance computing and communications network. The domestic Internet already links major universities, government research and supercomputing centers, and sources of research and development in the private sector.

The largest group of new users envisioned in the legislation is the pre-K/12 community. Previously perceived as necessary connections among scientists -- for knowledge advances and information dissemination in the national interest -- internetworked computer networks are now conceived of as the technologic equivalent of our country's highway system: the basic infrastructure for the interstate exchange of goods and products. Our nation is mainly transporting ideas and information instead of mostly manufactured goods. The national information highway, will interconnect, electronically, all those who teach and learn in direct dialogue and immediate information exchange, in real time, all the time, in a single and sustained learning community.

Just as we have valued our common schools to undergird the development of our democratic society, and prepare our people for economic self-sufficiency, we are beginning to appreciate internetworked computing and communications for its contribution to the common good: the democratic process we hold dear, the economic success we desire, the education we must demand if we are to realize our best hopes for the future.

Expanded and increased expectations for students mean we need better prepared teachers and teachers re-trained to bring students into the 21st century. We need teachers whose pedagogical repertoire is sufficiently broad to ensure that all students truly learn, teachers who share their subject-matter knowledge in rich ways, working collaboratively to organize instruction that effectively supports student learning.

Similarly, students must be shown how to access an array of knowledge resources, analyze and integrate information, and create new knowledge in partnership with others. Rethinking teaching and learning in the context of new standards and new assessment practices means providing opportunities for students to engage in meaningful work over longer periods of time with a focus on projects, products, and performances that help them become more fully engaged in generating, integrating, and displaying knowledge.

Decentralizing decision-making requires the participation of the whole school community in creating learning opportunities to develop the society we desire. We are rethinking the very organization of schools, and all educational activity within them, in an effort to better prepare our people to shape our shared future. We believe we need this new mechanism of network technology: to help school districts decentralize decisionmaking and develop new forms of accountability; to facilitate teacher-to-teacher communication of ideas and information, and development of more robust learning activities; and to enable students to explore knowledge and information, and work together in more meaningful ways.

A local school administrator recently likened Internet access to the Louisiana Purchase. Policymakers and public leaders may not fully understand the dimensions of what we are acquiring and developing. Although we know some spaces very well, we must explore a vast uncharted terrain. Moreover, this new frontier is in a state of constant development. It is not possible to know completely what we are getting -- in part because the reality is already greater than the comprehension of any one of us; in part because future possibilities will likely be more potent than present circumstances provide; in part because we are participants in the development of the resource itself, and our contributions shape development as we proceed.

We know enough now, however, to appreciate the value of, and comprehend the capacity for developing an extraordinary educational resource by capturing the knowledge and diversity of our people and providing a new form for teaching and learning. We already see a growing public perception that new information highways will change our purchasing patterns and entertainment expectations as a society, as well as transform individual access to information.

The information highways about which we are hearing so much in the popular media today differ from real roadbed in a number of significant ways. Unlike the transport of goods, where transportation means moving raw materials to manufacturing sites and products to markets, information transport, instead, opens up chances to design and redesign information products even as they are received by the consumers of knowledge and information, change products en route to designated destinations, and reroute units of production instantaneously.

But these transportation systems -- both physical and "information" highways -- share certain salient features as well. Standards of construction and inter-connection are essential for full functional access and use. The protocols for network technology deployment are as important as the specifications for grading and guardrails on roads and highways. We do not build bikepaths to our interstates or put stop lights on freeways for real reasons. Analogous reasoning shapes the standards for network connection and extension.

Educators must be extremely careful in deploying this new network technology. In the initial enthusiasm for internetworked communications, some local area networks have been built that are insufficient to support the traffic of high educational use. Like the corduroy roads of our early history, they cannot accommodate the vehicles of today. We have also constructed some local networks, sufficient to themselves, which cannot tie into the trunk line, as it were. Like the narrow gauge train tracks that served some areas of the Northeast so well, but could not attach to the transcontinental track last century, we already have some outmoded technology systems that require retrofitting to take advantage of full connectivity. Technical standards, like content standards, ensure capacity.

The NREN is, functionally, the contemporary equivalent of our interstate highways and our transcontinental tracks, offering pervasive, physical inter-state transportation of resources and products. Increasing demand requires more pervasive and robust infrastructure support, which is why the Gore bill contemplates a gigabit network for fully connecting our country electronically.

The very pervasiveness of the new national information highway is an assurance of equitable access to necessary information and knowledge. Just as a right to travel is assured to each of us constitutionally (to secure our privileges as citizens of the United States, not just the state in which we reside), so internetworked communications provides full participation for everyone "on" the network, regardless of their point of origin.

As we move to more comprehensive technology interfaces, integrating voice, video and data, it is becoming increasingly apparent that we need to think of technologic systems, as we have designed other transportation systems to support development and ensure performance. We need to link all aspects of the work involved in reaching our six national goals and integrate our disparate commitments to excellence: to connect teaching and learning activities more robustly across the curriculum and the learning continuum; to link learners and knowledge more directly; and to provide our people immediate and pervasive access to information. The magnitude of the problems that confront us in achieving educational excellence -- and the economic and social success that education should serve -- is simply too great for "tinkering." We need bold, concerted, and coordinated action to make meaningful change and realize real excellence. We think network technology is a powerful tool for systematic action and systemic support. And we believe it is in the interests of sound national policy to connect our concern with standards-based educational change to our country's commitment to electronically connecting knowledge resources.

In our Task Force report, we have explicated what we take to be the most desirable features of this new technology opportunity for re-forming education in our country. We have identified critical barriers to restructuring education with network technology. And we have recommended specific action to realize our Goals for educational excellence and, simultaneously, accelerate the pace of educational change.

If we are serious about achieving educational excellence, we believe we must be committed to internetworked computing and communications as a strategic investment in change. This new knowledge frontier is our future -- economically, socially, and educationally. Like the geographic frontier that defined American advances last century, the development of pervasive information access and computer-mediated communications extends the "reach" and the promise of America, and assures the continued progress that characterizes this nation and marks its value as "a city upon the hill."

The Desirability of Using Network Technology to Achieve Educational Excellence

[Rationales for Deployment and Utilization]

Section Outline

I. Support and Accelerate Systemic Change for Educational Excellence

- Break down barriers of distance, time, and isolation; build new partnerships to amplify knowledge.
- Restructure schools for exploration, inquiry and analysis, and the integration of knowledge and information.
- Support development and dissemination of a standards-based curriculum.
- Offer new assessment mechanisms; monitor systemic change.

II. Reconstruct and Improve Teaching

- Challenge and support teachers.
- Foster a collegial, cooperative spirit among teachers to develop a professional community of educators.
- Prepare and support teachers in educating with a standards-based curriculum.
- Enable teachers to deliver high quality instruction to all students.
- Assist teachers in engaging and empowering students, encouraging proactive learners.

III. Expand and Enrich Learning Opportunities

- Challenge and inspire students.
- Expand knowledge resources; encourage interpersonal connection and interactive learning.
- Empower learners to take charge of their own learning by giving them control of their learning environments.
- Prepare individuals to participate in the modern workforce by teaching with the tools of the modern workplace.
- Enfranchise our citizens in a new democratic community through increased knowledge-sharing and collaborative activity.

IV. Link Schools and Society to Improve Economic Productivity and Encourage Lifelong Learning

- Create environments inside and outside school that encourage learning.
- Link families and schools to support children's growth and understanding.
- Merge the environments of the school, the community, and the workplace.
- Break down barriers of distance, time, and isolation; create new communities and connections among our people.

The Desirability of Using Network Technology to Achieve Educational Excellence

Network technology will enable us to:

I. Support and Accelerate Systemic Change for Educational Excellence

Profound social and economic change is affecting the environment in which we live and work. The restructuring of our domestic economy around the growth sectors of information and services, and the popular demand for emerging communications tools, are trends that suggest that American education will be conceived and delivered differently in the near future.

We need technically sophisticated mechanisms for educating our people, which are the modern means for developing a vital, contemporary society. We need technologically rich environments for active and engaging learning experiences. We need state-of-the-art assessment mechanisms to ensure that everyone benefits from rich and demanding instruction and exploration, and can meaningfully integrate available information. We need networks of learners, interconnected with knowledge resources and each other, to support lifelong learning for all our citizens.

Networking technologies -- particularly to extend computing and communications capacities among educators, students, and community resources -- hold special promise for maximizing the availability of information resources, expanding knowledge resources and interactions, and accelerating the pace of change itself.

The Task Force has identified four significant ways that network technology can creatively transform the nation's educational system to support and accelerate systemic change for excellence in education. These are outlined and explained below. Network technology can:

1) *Break down barriers of distance, time, and isolation; build new partnerships to amplify knowledge opportunities.*

- By making communication more convenient, network technology helps interaction become more immediate and information become more accessible.
- By changing the way we think about and use information, network technology opens up knowledge environments to the whole society.

- By providing pervasive access to our society's knowledge resources, network technology equalizes knowledge and resource distribution, and, thereby, equalizes educational opportunity.

- By encouraging collaboration among all stakeholders in American education, network technology supports a new social dialogue.

- By interconnecting our society electronically to incorporate individual contributions, network technology enables these contributions to build on each other and maximize their social benefit, as well as educational attainment and economic return.

- By encouraging regular, real-time interactions among our people in sharing ideas, addressing issues, and solving problems, network technology supports public decision-making and informed consensus.

(2) *Restructure schools for exploration, inquiry and analysis, and the integration of knowledge and information.*

- Informed and responsible public officials, working with public and private-sector interests, can link our whole society electronically for meaningful interaction, to aid in full democratic participation and economic development.

- Educational leaders, wisely investing in network technology infrastructure, can recreate education by building the information transport system on which our future education will depend.

- Committed teachers, open to learning new ways of accessing and sharing information, can engage students in more vibrant and meaningful learning activities, and encourage them to take responsibility for their own learning.

- Supportive parents, working with public and educational leaders, can connect homes and schools to forge a new kind of partnership that supports their children's learning.

(3) *Support development and dissemination of a standards-based curriculum.*

- Because systemic change is continuous throughout education, collaboration and coordination of the contributions of diverse agencies and actors is helped by the speed and currency of networking, particularly in developing learning standards in core subject matter.

- To achieve national educational excellence, the policies of states and local school districts must be consistent with national standards. Networking technology can disseminate new standards efficiently and effectively, relating them to the relevant instructional materials and performance-assessment prototypes.

- The successful implementation of national standards in education requires that they be debated, tested, and acted upon, taking account of numerous interests. Network technology increases communications capacity, provides a nationwide forum for analyzing and sharing results, and creates the critical mass of participation necessary to promote continuous educational renewal.

(4) *Offer new assessment mechanisms; monitor systemic change.*

- Technically, networked computing and communications provide unlimited opportunities for ongoing data collection and analysis in the assessment of the quality of student work, teacher effectiveness, organizational support, and progress toward our National Goals.

- Instrumentally, pervasive electronically mediated communication can check on the technical adequacy and substantive sufficiency of network technology to achieve our Goals for reforming our schools.

- Instructionally, the communications capacity of network technology enables public and educational leaders to ascertain effective technology applications and also encourages strategic system-wide improvements.

- For monitoring, network technology deployment and utilization across the country will facilitate more general monitoring of systemic reform, reflecting its pervasiveness, robustness, level and type of use, and patterns of access and interconnection.

II. Reconstruct and Improve Teaching

In the last decade of the twentieth century, teacher-centered, textbook-oriented education is largely obsolete. Internetworked communications offer students access to more information than teachers can possibly master, as well as an immediacy and currency of information that textbooks -- periodically adopted and distributed -- can never maintain.

Effective use of this technology, however, requires that teachers shift from whole-group, frontal instruction to coaching individuals and small groups of students, and move from "telling" information to "facilitating" information-gathering and the integration of knowledge.

To gain full value from network information technology, teachers must also shift from an expectation that all students will learn the same thing at the same time, and accept that different students learn different things at differing times. Teachers will also need to change their assessments of students' learning from over-reliance on standardized and norm-referenced test results to more focus on students' products, performance, and progress toward identified learning goals.

Electronic networks can be used to establish and sustain "virtual communities" of educators that can exchange information, ideas, advice, and materials at any time and among many settings: classrooms, homes, offices, university facilities, laboratories and libraries. These networks can be used to support daily interactions among teachers, to deliver instructional materials, to design and evaluate learning activities, and to direct participants to special resources.

The Task Force notes five important ways that internetworked communications can reconstruct and improve teaching practices. These are outlined and explained below. Networked communication can:

(1) *Challenge and support teachers.*

- Teachers typically work in isolation, with little opportunity for interaction with their peers. Networked communication enables teachers to interact with each other in real-time, anytime, to share problems, discuss solutions, organize learning activities, engage in multi-site review and assessment, and support each other in their professional lives.

- Scarce resources, discipline problems, and perceived lack of external support further isolate teachers, while leaving them little time, energy, and money for developing creative and challenging learning opportunities. Network technology expands the array of information and instructional supports readily available to teachers.

- Large classes frustrate many teachers and reduce their instructional effectiveness. Network technology enables teachers to rely on off-site, "virtual" classroom experiences that involve students simultaneously in diverse and engaging learning activities.

- Network technology enlarges the human resource-pool available to teachers, providing access to professional educators, subject-matter specialists, parents, and community resources across the country and around the world.

(2) *Foster a collegial, cooperative spirit among teachers and develop a professional community of educators.*

- Teachers are called upon to be sole-source providers of ever-greater amounts of knowledge and types of learning experiences. Network technology offers teachers almost unlimited expertise and "partners" in instructional activity.

- Good teaching evolves from reflective practice. Classrooms are learning laboratories and, like other researchers, teachers need to share and analyze their work. Internetworked communication offers a new and unique opportunity for regular interaction and sustained professional exchange among teachers.

- Pre-college teachers need access not only to the practical wisdom of other classroom practitioners, but also to the research applications of college counterparts. Network technology already interconnects university researchers across the country. Providing pre-K/12 educators access to their post-secondary colleagues invites reciprocal pre- and post-secondary exchange for ongoing educational renewal.

- Networking technology eliminates customary barriers to sustained professional development by giving teachers significant control over the substance and timing of their own learning, and offering them regular opportunities to learn with colleagues and co-workers.

- On-line sharing of information enables educators to learn about the application and integration of information technology within the field of education, developed by educators for educators. This method of communication becomes less costly and less onerous for educators, once they are introduced to initial uses and functions.

(3) *Prepare and support teachers in educating with a standards–based curriculum.*

- Standards–based instruction requires that teachers be able to quickly utilize free and low–cost text, video, information databases, and computer software. Electronic networks allow teachers to quickly locate, view, hear, copy, and even interact with a vast array of free instructional resources.

- Timely translation of new standards into school programs and individual and class activities requires their immediate transmission throughout the educational system. The greater the communications capacity, the more thoroughly this dissemination and discussion can occur.

- Emerging curriculum standards call for performance measures that are still under development. To implement these curriculum standards in a timely manner, teachers must have immediate access to prototypic assessment tasks, guidelines for evaluating student performance on those tasks, and tools for efficiently recording and reporting qualitative measures of performance.

- Conversely, developers of the new assessment materials need access to classrooms in which to try out sample tasks and procedures; they need immediate feedback from teachers and students using the materials. Widespread availability of the experimental assessment materials will increase understanding and stimulate implementation of new curriculum standards; broad use of prototypic assessment materials in association with the standards is necessary for the refinement of new assessment tools.

- Assessment tasks and procedures aligned with national curriculum standards are being developed by state agencies, professional groups, research centers, universities, and commercial firms. Electronic networking can be used to develop banks of observation criteria and make a pool of new assessment materials widely available to researchers and classroom practitioners.

- The national goal of standards–based systemic reform in education carries the requirement of lifelong professional growth in both content knowledge and pedagogical skills. Network technology enables teachers to engage in a customized, continuous program of staff development, available from their desktop personal computers.

(4) *Enable teachers to deliver high-quality instruction to all students.*

- By putting educators and their communities in closer contact with needed information and resource materials, network technology enables them to draw on more current and amplified knowledge resources and make better decisions about teaching strategies, meeting diverse needs more effectively.

- Network technology can help close the gap in access to knowledge for increasing numbers of students by bringing more effective learning tools and materials into teachers' hands, more immediately and regularly, as well as putting both teachers and students into contact with a wider array of people and information, anytime, anyplace.

- Internetworked computing and communications can support a national assessment system that allows us to determine how well we are delivering high-quality education to all students, while preserving flexibility for states, districts, and schools to individualize high expectations and invest differentially in system supports.

(5) *Assist teachers in engaging and empowering students and encouraging proactive learners.*

- Teachers have few opportunities to introduce students to the world beyond the classroom walls and engage them in interactive learning activities beyond customary small-group work and role-playing simulations. Network connections make possible real-life, real-time interactions of mixed-age multi-interest groups, as well as collaborative inquiry of every conceivable kind.

- An array of learning opportunities well beyond the options of classrooms, schools, or local communities, will entice students to learn in increasingly vital ways and encourage interest in learning and making meaning of disparate resources and experiences.

- By providing students opportunities for defining their own learning environments, pacing their involvement according to their own interests, and personalizing inquiry and analysis, network technology will empower students to take charge of their own learning.

III. Expand and Enrich Learning Opportunities

Extending Internet connections to schools will provide all students access to the electronically based knowledge resources and vital information retrieval activities that are redefining American life, and will raise students' levels of technical literacy for the effective use of the tools of our emerging Information Society.

When we quantumly increase resources and provide multi-dimensional communications capacity, learners and knowledge workers will be able to develop imaginative and innovative responses to complex problems, to process information, and to generate and disseminate new knowledge. They will challenge and change both the nature of what is known and the forms for apprehending knowledge and information.

Research and sound reasoning help us understand that learners should be in charge of their own academic work; proactive learners are constantly involved in making decisions about what they learn and how they learn. Real learning activities are multi-sensory experiences, enabling students to learn the means that offer them opportunities to visualize, compose, create, compare, communicate, and integrate knowledge from disparate sources in diverse media.

Educational excellence requires expanding and enriching students' opportunities to learn. Networking technologies rearrange and increase the amount of available knowledge and information, and also alter and improve the modes for accessing and integrating knowledge and information.

The Task Force has identified five major ways that network technology can expand and enrich learning opportunities. These are outlined and explained below. Network technology can:

(1) *Challenge and inspire students.*

- Contemporary American students are accustomed to the participatory activity of videography and adept at manipulating electronic environments for entertainment. It makes sense to challenge these students educationally in the medium with which they are most comfortable.

- Too few classrooms encourage students to think independently or to take responsibility for their own learning and achievement as individuals. Telecommunications technology can open a world of varied and virtually unlimited knowledge resources to students, supporting independent inquiry and analysis.

- Students have limited interactions with teachers and each other. Networking classrooms and schools will enable students to engage in more numerous and more vibrant interactions for more rewarding and enriching academic work.

(2) *Expand knowledge resources; encourage interpersonal connection and interactive learning.*

- The national unity for our social diversity that we have sought through schools (in textbooks and tests) is offered to us in a new form: the web of electronic interconnections that can link us for developing contemporary America.

- Interconnected electronically, students can work together in myriad configurations, effectively creating on-line labs for data-sharing and analysis, writing across the curriculum and across the country, developing "virtual communities" for solving multi-faceted problems, and involving more people in the search for solutions.

- With electronic interconnections, students have access to more challenging materials, more teachers and human resources, and more diverse sources of knowledge and information with which to shape more meaningful learning.

- Networks bring students into direct contact with multiple cultures in compelling, interpersonal interactions. Cross-national collaboration, language and culture studies, and diverse and multicultural perspectives can be instantaneously incorporated in students' learning.

- Network technology effectively democratizes knowledge and equalizes access. Insofar as the technology is fully and fairly deployed, access to knowledge is equally distributed and opportunities to participate are equally available.

(3) *Empower learners to take charge of their own learning by giving them control of their learning environments.*

- Fully deploying network technology gives the tools for social change to the people themselves -- as knowledge is democratized, so are the tools of its use. Learners at every level have the power to transform themselves as well as their society through new forms of knowledge acquisition and exchange and new kinds of collaborative work.

- Access to networked computing and communications enables students to become proactive learners, engaged in acquiring, integrating, and sharing knowledge and information. This vibrant interaction and exchange is more likely to hold students' attention and encourage involvement. (Students who drop out of school or engage in unsafe activities are not actively engaged in learning or have opted out of boring and non-involving school activity. Knowledge seekers create their own self-discipline.)

- Because proactive learners are motivated to know, and actively engaged in learning, which leads to greater achievement, network technology has the potential for engaging and sustaining students' interest and elevating student achievement.

- Scientific inquiry and mathematical problem-solving require active learning. System support for engaging and interesting math and science study can be expected to increase scientific and mathematical achievement, as it has supported scientific advances in the research community.

- Those who take charge of their own learning are learners for life. Network technology offers opportunities for active learning now, as well as the skills development and experience to continue to access and work with information in the future.

(4) *Prepare individuals to participate in the modern workforce by teaching with the tools of the modern workplace.*

- Schooling must prepare students to manage large and diverse information resources in making personal, social, and work-related decisions. The tools and procedures employed in schools should closely approximate those used in most modern institutions.

- Increased communications capacities and multiple forms for interconnecting the environments of work and entertainment are changing. The internetworking of learners prepares them to benefit from available information and participate in knowledge development.

- Network technology provides a forum for students to display and improve their work. On-line interaction supports learning-by-doing and reinforces effort and achievement.

(5) *Enfranchise our citizens in a new democratic community through increased knowledge-sharing and collaborative activity.*

- Network technology is characterized by individual interest, personal commitment, and shared work. Students are free to explore knowledge opportunities in the richest information environment that has yet been conceived.

- Opportunities for full social participation are the essence of political equitability in our democracy. Education, as the primary enfranchising activity of our society, can maximize the opportunities for participation through internetworked communication.

- By developing an ethos of collaboration and cooperation in education, internetworked computing and communications enable individuals to reshape our democratic society, in reciprocal and interdependent social interaction, for the maximum benefit of all our citizens.

IV. Link Schools and Society to Improve Economic Productivity and Encourage Lifelong Learning

The National Education Goals Report is subtitled "Building a Nation of Learners," emphasizing a sustained commitment by all sectors of society to creating and reinforcing a national culture that takes learning seriously. Network technology provides a unique opportunity for breaking down the barriers between schools, families, and community institutions.

Electronically connecting schools and homes will provide fast, immediate, continuous, and efficient communications between parents and their children's teachers. While the substance of the communications is extremely important, an additional, critical benefit of regular, electronic interaction is cementing the bond between parents and teachers as educating "partners" who regularly communicate with each other.

Similarly, linking learning activities and work environments prepares students for their lives after formal schooling. The knowledge resources of the private sector expand the knowledge and information available in schools. Moreover, students are prepared to use the technological tools of today to design the economic achievements of tomorrow.

Connecting family and community resources to students' formal learning environments demonstrates the integrity and utility of knowledge and creates a continuum of resources for learning now and in the future.

The Task Force has four recommendations for linking schools and society to improve economic productivity and encourage lifelong learning. They are outlined and explained below.

(1) *Create environments inside and outside school that encourage learning.*

- Over time, educating learners by fully engaging them in their own learning and giving them increasing knowledge opportunities will pay dividends in learning gains, increased social contribution, decreased alienation and crime, and lower dependency rates for public assistance.

- Flexible, inexpensive learning opportunities -- driven by individual choice and available throughout the community through an evolving, multi-site network infrastructure -- can blur the boundaries that artificially segment learning as something that occurs formally in schools and informally in the communities in which we live and work.

- A robust network technology infrastructure, accessible for education and the whole community, can raise the content and technical literacy levels for all adults and maintain the currentness of knowledge.

(2) *Link families and schools to support children's growth and understanding.*

- Internetworked communication will enable parents to be fully engaged in the educational process as teaching partners, and will provide them the tools necessary to become constructive educators themselves.

- Electronic interconnection will enable parents to interact with each other and to share in an array of parenting resources to improve their own skills, thereby helping their children's learning and development.

- Developing new and constructive relationships between parents and classrooms will integrate children's learning experiences, enable parents to participate more fully in their children's education, and provide important support for teachers' work.

(3) *Merge the environments of the school, the community, and the workplace.*

- The National Education Goals require that education go beyond the acquisition of information to the creation of new ideas and the thoughtful application of knowledge to problem-solving and decisionmaking. Electronically interconnecting schools and places of employment can expand students' learning opportunities and assist them in becoming knowledge workers.

- Workplaces in all economic sectors are being transformed by an expanding array of information technologies. Core work processes at every level incorporate information-rich and technologically advanced tasks and interactions. The high-skill jobs associated with our country's emerging technologies place a premium on creativity, collaboration, effective information management, problem-solving, and continuous learning.

- For our youth to shape and participate effectively in the emerging Information Society that is transforming our country's economic activity, and for the American workforce to compete successfully internationally, all students must be prepared with the technological literacy and thinking skills they will need for productive employment and lifelong learning.

(4) *Break down barriers of distance, time, and isolation; create new communities and connections among our people.*

- Telecommunications system connections are becoming increasingly common in government and the private sector -- for expanded research and development capacity, enriched employee communications and customer services, and improved information collection and analysis, and management processes. Connecting schools and homes to relevant public and private sector resources will improve students' near-term knowledge acquisition and prepare them for 21st-century work environments.

- Internetworked computing and communications assure rapid information exchanges across all sectors of society. Network technology is a medium for technology transfer, a forum for creating and producing new knowledge, and a mechanism for observing and evaluating social progress in technological deployment and application.

- Network technology is the modern equivalent of the communications and transportation systems of mid-nineteenth century America, and more recently, the interstate highway system, that increased Americans' physical and communications connections and made possible the mobility that altered economic production and redesigned social interactions. Reducing the isolation of our people changed the nature of our political community and made possible new forms of economic development and social activity. Today we are poised for a similar revolution in communications transport, a new development frontier for realizing the promise of America.

Barriers to Realizing Educational Excellence Using Network Technology

[Problems in Deployment and Utilization]

No matter how desirable the prospective benefits of internetworked communications for education, real barriers could foreclose the promise that network technology affords, and bar the likely benefits for educational reform. The intransigence and inertia of schools in the face of forceful calls for fundamental change; ill-prepared and inexperienced educators, unable to work effectively in the electronic learning environments of our future; limits on students' access to knowledge and information; and the separation of schools from society -- family, work, and community -- combine to undermine the best efforts of enlightened leaders.

Realistic planning for relying on network technology to restructure education demands a clear confrontation of the barriers before us, and the problems and resistance to be overcome, in achieving educational excellence in America.

The Task Force has identified four systemic barriers to realizing educational excellence through the use of network technology. These are outlined and explained below.

I. Schools' Organizational Resistance to Change and Lack of Technology Systems Support

- Administrative centralism characterizes most school organizations. The rigid control of schooling practice and process constricts the possibilities for restructuring learning environments and "delivering" education differently.
- The reward structure of American schooling supports the *status quo*: few incentives are in place to encourage innovation. Schools have demonstrated a powerful resistance to fundamental functional change, tending to make only marginal adjustments in educational practices.
- Most school administrators were professionally trained before the development of networked computing and communication and are unfamiliar with its power, unprepared to make equipment acquisition decisions, and unaccustomed to supporting the new electronic teaching and learning environments.

- Educational technologists have not been professionally trained in network technology, and they are unprepared for the engineering decisions of its deployment. Although some are familiar with computerized records and data transmission, they are inexperienced in system support for teaching and learning. Patterns of dependence on vendors and services providers have limited their expertise to administrative data management.

- The cost of computers and the network technology investments to connect classrooms and schools limit connectivity. Significant new sources of support and real reallocation of existing funds is required to instantiate internetworked technologies in schools.

- Inequitable distribution of technology resources across districts and states exacerbates inabilities to participate in networked communication, and limits many students' access to available learning resources.

- Professional network engineers' lack of knowledge about education generally, and national commitment to reform, in particular, results in either an attitude of *noblesse oblige*, or a condescension in building second-rate telecomputing systems for schools.

- Differential and, in some instances, exorbitant telephone service charges inhibit or foreclose educational access to internetworked communication. Unresponsive public utilities, cable television franchises, and community media undermine educational participation in developing information communities.

II. <u>Inadequate Teacher Preparation and Insufficient Support for New Modes of Instruction</u>

- The traditional role of teachers (knowledge-transmitters) to students (knowledge-receivers) is antithetical to the knowledge exchange characterizing internetworked communication and resource acquisition. Focusing on the simple uni-directional and diadic relationships of teachers-to-students ignores the relationship of each group to peers, to knowledge, and to the construction of meaning.

- Inadequate technology training in Colleges of Education limits what teachers know and can do in electronically mediated knowledge environments; this serves as a disincentive for them to do their work differently.

- Teachers do not have enough time for what they are expected to do now, let alone learn something new and plan for its effective use. User-interfaces are perceived as too difficult or off-putting by teachers needing quick access to network resources.

- Teachers are unaccustomed to making decisions about education beyond their classroom doors; they are unfamiliar with the appropriate curricular and instructional considerations to realize the full effect of networked technology resources.

- Teachers who have never had a telephone in their classrooms or a computer for personal use do not know how to access learning resources on-line. Their classrooms are not "wired" to take advantage of the learning resources available to them right now, and few teachers know how to request what they will need.

- Too many reform efforts have imposed external expectations for instructional improvement, breeding teacher resistance to change. Yet teachers are unaccustomed to colleagueship and lack practice in professional peer conversation and interaction around issues of instructional improvement.

- Traditional in-service education is insufficient for the technology training and practice-in-use teachers need for effective participation in networked communication and resource acquisition. And, although electronically networked learning opportunities could be designed for re-training, teachers have no experience with upgrading their knowledge and skills *in the workplace*.

III. Narrow and Outmoded Instructional Practices and Limited Access to Knowledge and Information

- Whole-group frontal instruction, with item-responses from students, characterizes most classroom instruction. Students are unaccustomed to controlling their own learning and they are unfamiliar with accessing and using interactive knowledge resources.

- Rigidly controlled classroom environments, centered on the teacher–as–expert, narrow the knowledge resources available to students and negate their diverse interests and experiences.

- Neither teachers nor students are accustomed to high levels of interaction in student learning activities. Nor are they experienced in manipulating and analyzing data and information, and broadly disseminating the results of their work.

- Students are not used to long–term, complex learning opportunities, nor are they experienced with cooperative, cross–site information exchange. Traditional assessment practices constrain students' perception of what "counts" as knowledge, learning, and achievement.

- Students' learning lives are separated according to "formal" and "informal" education. Little effort is now made to integrate their experiences and help them make meaning of their knowledge.

- Much of the information available to students in schools is outdated before it arrives. Knowledge cannot be kept current when textbooks are published and adopted on five– to ten–year cycles.

- Currently, students who have access to internetworked communications tend to "trivialize" their use of this medium. Without learning goals and instructional guidance, they "play" electronically, but have few genuine learning experiences.

- Inequitable access to knowledge characterizes most students' experience; requiring new levels of investment in educational technology may exacerbate existing inequities in opportunity.

IV. <u>Schools' Disconnection from the Larger Society and Inexperience with Advanced Technology Resources</u>

- Teachers and students tend to view the school environment as isolated and separated from the rest of their lives: schooling is organized and conducted to secure its separation from society.

- Schools do not welcome parents and the public to full partnership in educating children and youth. Communications between schools, families, and communities are few and frequently unsatisfactory; misunderstandings and "blaming" often takes the place of a shared sense of responsibility for children's academic and social success.

- We have never prepared adults for the responsibility of guiding children's growth and development. Schools have not been resources for educating parents and the public.

- Parents and the public do not take serious responsibility for educating all our children for the good of the whole society. Schools are asked to do too much, unconnected to other institutions and resources.

- Students in schools are disconnected from future workplaces; they are neither taught with the tools of the modern workplace, nor acculturated to the creative, collaborative environments of today's cutting-edge companies.

- Inadequately deployed network technology thwarts the robust connections of schools, homes, and community institutions. The limited public access of computers excludes less economically advantaged citizens from full participation in new knowledge networks.

A Blueprint for Educational Excellence
Using Network Technology

[Recommendations for Deployment and Utilization]

To obtain the results we want in education, we must make a number of important, simultaneous investments in technical capacity-building and content enhancement.

Network technology is a powerful tool for restructuring teaching and learning and accelerating the pace of educational change, but we must build this new support system wisely and well. Therefore, we need to take into account the known barriers to pervasive technology deployment and comprehensive educational change.

The Task Force has four major recommendations for deployment and utilization in a blueprint for educational excellence using network technology:

I. Invest in the Appropriate Infrastructure for Real Educational Reform and Restructuring.

It is impossible to overstate the importance of wise investments in information infrastructure and the value of agreed-upon protocols for ensuring high-quality information access and exchange. A fundamental principle of inter-operability must obtain at all times, but flexibility is possible in many ways. It is essential to follow federal standards development, and insist on the best available technology for achieving high standards technically and educationally.

The Task Force has identified six major priorities for investment in the appropriate infrastructure for real educational reform and restructuring. These are outlined and explained below.

(1) *Invest in research and development to maximize elementary and secondary education's electronic interconnections -- with each other, post-secondary education, and the disparate knowledge resources of our emerging Information Society.*

- Insist on technology planning -- at every level -- that is content-based, predicated on inter-institutional connectivity, and specifically designed to support educational restructuring.

- Invest in a new national research agenda for educational excellence using networked technology resources: hardware deployment, software development, courseware creation, and the teacher training essential to ensure high-quality learning.

- Dedicate Goals 2000 funds for state and local technical assistance in using network technology for restructuring teaching and learning to realize the National Education Goals.

- Provide matching grants for technology deployment for innovative network dissemination of curriculum standards to increase the rate of progress on the Goals.

- Require state investments to physically connect schools and districts to the Internet, and to provide dial-up accounts for remote access and to serve as interim connections for maximum use.

- Expand national and state financial supports for partnerships of research universities (and mid-level networks and national labs) and surrounding schools. These universities (and networks and labs) are already internetworked and experienced in Internet access and use, and can provide both technical and content support to schools.

- Develop grants programs in education as incentives for post-secondary educators to work directly with elementary and secondary teachers and students in order to familiarize them with internetworked computing and communications, and to assist them in restructuring pre-K/12 learning environments.

- Train new educational technologists in the special technical knowledge required for network management and monitoring. We need a well-trained cadre of network managers who can "cobble together" and maintain the local infrastructure to ensure the access and interactions we require.[1]

1 Network managers must determine proper routing parameters for optimal and reliable network operation; assign network Internet Protocol (IP) addresses and maintain a network accessible database of node names corresponding to each address; and monitor network operations (constant observation of the "health" of the network, network components, and external network connectivity; performance documentation and recommendations for enhancement or re-engineering; and problem-resolution).

- Re-evaluate and reconstruct school data systems to include monitoring local network technology deployment and utilization, formative evaluation of reform and restructuring, and new assessments of student learning in a standards-based curriculum.

- Encourage pre-K/12 educators to "own" their own technology transfer, and to develop and share useful applications.

- Support schools as centers of change; move resources to learning sites as quickly as possible, and develop incentives and rewards for restructuring learning with internetworked information access and exchange.

(2) *Clarify responsibilities for technology development and deployment.*

- Charge the Office of Science Technology Policy (OSTP) with integrating educational networking into mechanisms for national networking. (E.g., require the Federal Networking Council to incorporate strong educational participation in its work.)

- Revivify the national role in research and development for technological capacity and utility. Call for explicit investments from the Departments of Energy, Commerce, and Education, under the coordination of the National Science Foundation (because its work is field-initiated, and it is connected both to science research and education), to increase internetworked communications in education and to expand and improve content resources.

- Continue a Goals Panel Task Force to monitor network technology deployment across the states and to focus attention on achieving the national Goals.

- Identify trusted and technologically knowledgeable resource-persons, as well as experts in educational reform, to participate in major planning, deployment decisions, user-support developments, and assessment activities.

- Demand statewide technology planning that includes inventories of existing technology investments, gap analyses, assessments of inter-institutional connectivity, and measures of public support, as well as plans for subsequent investments, sequencing action, and meeting constituent interests. Make sure that educators are included in the planning processes for public investments. Organize state-level reviews of district technology plans to ensure maximum interconnection and comparability of design specifications. Be vigilant to

forestall the deployment of inadequate technology and making unwise investments for short-term gain that might limit pervasive access in the future.

- Require periodic reviews -- at every level -- not only of progress on deploying network technology, but also of the extent to which internetworked computing and communication is contributing to the achievement of the National Education Goals.

- Work closely with technology enthusiasts in local communities and school-sites, adopting a "skunk works" approach to technology deployment and utilization: providing more "stuff" to those who use the most and share with others.

(3) *Tie all external technology investments to local deployment decisions that take account of agreed-upon protocols and maximize robust connectivity.*

- Communicate that standards -- technically and educationally -- are thresholds for experiences of quality. Minimal levels of technical capacity are essential for realizing real learning goals.

- Adopt for the pre-K/12 community, the set of networking protocols required for NSFnet, "network of networks," participation: the TCP/IP protocol suite, IP routers for direct access, and high-speed local area networks which offer equal access and simultaneous opportunities for participation from any point on the LAN.

- Look to "lighthouse" states, districts, and schools[2] for guidance in providing direct teacher and student access to the National Research and Education Network -- fulfilling the federal requirement for connecting all educational institutions and research and resource centers.

2 E.g., California; Bellevue, Washington; and The Catlin Gable School, Portland, Oregon.

- Design topologies for interconnecting schools that are both cost-effective and manageable. Educational communications must be reliable and of sufficient capacity to support primary applications as well as allow development of new applications.[3]

- Locate network servers where they can be appropriately managed and supported, provide access paths with adequate bandwidth, and "customize" resources to local needs and assets. (School and district decisionmakers must become much more enlightened about deployment decisions in order to ensure the robust connections that will enable useful access to networked knowledge resources, rapid and responsive intercommunications, and the capacity to "grow" the system as needs change and use increases.)

- Ensure the best possible connection and response-time. Ethernet is preferred for most LANs because of its speed and general availability.

- Integrate existing computers and peripherals in schools, as much as possible, into the networked communications system. This installed base represents a large investment, even with dated equipment, and most schools and districts must work with what they have rather than contemplate *de novo* development.

- Build expandable and upgradable systems anticipating changes as technology improves and user-demand increases.

- For maximum capacity and utility, provide schools direct Internet connection, in conjunction with a LAN that delivers Internet access to the desktop.[4] (Some pre-K/12 educators and public decision-makers are calling for phone lines to every classroom. While telephones may be desirable for some direct communication, if new wiring is necessary for classrooms and schools, direct electronic communications makes more sense than relying on modem-mediated access to internetworked resources.)

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3 Capacity is measured both by total data traffic volume and by response time when information is requested over the network. [Capacity should be such that no more than 10% of the communication bandwidth is used during a typical work day.] Reliability is measured by the percentage of the time that the network is able to transport data. [Reliability should be well over 99.7%.]

4 Two twisted pair cable is considered a minimum standard for premise wiring, and four pair preferred by network technology planners looking to the next generation of network development. Wireless connections are also in development which could increase options for full connectivity.

- Avoid building costly state backbone infrastructure. Interconnection of schools and services can be accomplished simply by adopting Internet protocols and acquiring Internet connection service. (Connection service must meet criteria for reliability and capacity, but connection to any Internet service provider will provide communication capability to all other Internet subscribers -- locally, nationally, and internationally.)

- Invest in professional network engineering for organizing existing computer resources, building LANs, and interconnecting schools across a district, wholly or in sub-network system configurations.

- Prepare the pre-K/12 community to participate equally in the network of networks now electronically linking research and knowledge-sharing activities across our country. (School, district, and state networks will be expected to develop and maintain their respective electronic domains and to be good "citizens" of the internetworked communications communities.)

(4) *Ensure equality of educational access through technology deployment decisions.*

- Develop review processes at every level to ensure the representation of relevant interests and perspectives in electronic interconnection.

- Charge state and local governments, districts, and schools, in any technology or educational decision-making, to maximize access and instructional benefit.

- Provide for the connection of geographically isolated schools and communities -- offering a complement of dial-up accounts to balance urban infrastructure development.

- Sequence physical access to maximize diverse teacher and student participation and ensure fair distribution of knowledge resources.

- Educate educators to the egalitarian ethos of the Internet (oblivious to age, race, class, gender, or economic condition) and encourage sensitivity to how a genuinely equitable learning environment distributes access and ensures fairness.

(5) *Educate educational decisionmakers to relevant issues in deployment, access, and use of this new knowledge environment.*

- Deploy network technology to protect personal privacy, safeguard students' access according to community norms, and ensure the integrity of users' work on-line.
- Educate teachers and learners in electronic "netiquette" to encourage open, respectful exchange and maximize knowledge-sharing.
- Use peer pressure to enforce high quality uses for internetworked communications. (Communities of teachers and learners can best protect their own interests.)

(6) *Generate educational policy dialogue and dissemination activities around issues of network technology deployment and internetworked resource distribution.*

- Call for national and state conferences to focus on using network technology to reform and restructure education and reach our National Goals for educational excellence.
- Engage national professional organizations and associations in focusing attention on relevant issues and important possibilities for interconnecting electronic media in education.
- Provide immediate federal support for electronically connecting major state-spanning restructuring networks across the country to increase the potency of their work and serve as reform resources to others.
- Identify significant resources, learning opportunities, and strategic plans to assist communities in internetworking communications and reforming schools.
- Provide opportunities at all levels of decisionmaking for sharing plans and documentation on deployment and use.
- Use the popular media to publicize this new educational tool. Insert model network technology uses and activities in regular television entertainment programming to show Americans how structurally redesigned schooling and learning work in this electronic information environment.

II. Provide Extensive Professional Development to Maximize the Likelihood of Robust Changes in Curriculum and Instruction.

Network technology means re-thinking and improving the professional development of teachers. Teacher education must change to include induction into electronic network communication. In-service education should be fundamentally altered by customizing learning and bringing knowledge resources and professional assistance to educators' workplaces. Educators must be offered systematic opportunities for developing professional communities, using the best available knowledge and resources to teach a standards-based curriculum and ensure robust learning outcomes for all students.

The Task Force has four major recommendations to provide extensive professional development to maximize the likelihood of robust changes in curriculum and instruction. These are outlined and explained below.

(1) *Invest in educators' learning to access and use network resources.*

- Encourage school, district, state, and national investments for introducing educators to the use of network-based knowledge and information resources and assisting them in transforming current practice.
- Insist that pre-professional teacher preparation programs integrate network technology in courses and content, substantively preparing teachers for new learning environments as a condition for certification to practice.
- Argue for conscientiously re-designing in-service opportunities for professional development at every level, to introduce educators to new communications technologies, help them re-think their work in these new learning environments, and model high-quality on-line interactions.
- Support post-secondary educational technology programs to prepare technical specialists -- network engineers, software designers, and other technical support personnel -- to help schools and districts across the states to deploy and use these new tools wisely and well.
- Link state and national technology investments to local commitments to restructuring, thereby supporting educators who are serious about modernizing education.

(2) *Offer incentives for professional growth in learning about network technology and using on-line resources to improve curriculum and instruction.*

- Dedicate time for teachers to learn new knowledge and to try new teaching practices: restructured in-service education and reordered planning periods in districts and schools; and special seminars and summer institutes sponsored by colleges and universities, professional associations, and state and federal agencies.

- Remind the federal government of the post-Sputnik era investments in science education; similar summer institutes for teachers are needed now to induct educators in working effectively in this new knowledge environment.

- Call on professional associations, with national support, to use internetworked communications to shape and disseminate national standards in the disciplines, similar to the exemplary work of the National Council of Teachers of Mathematics.

- Provide F.I.P.S.E.-like grants to teacher-preparing institutions to integrate network technology -- as content source and instructional method -- in pre-service and in-service education programs.

- Develop in-state recognition of districts, schools, and classrooms that reorganize teacher time to take advantage of electronic learning resources.

- Develop "virtual" demonstration sites for highlighting network-based information resources and showcasing curricular and instructional activities to foster teacher-to-teacher information exchange and resource-sharing.

(3) *Provide technical assistance to help educators improve education.*

- Fund technical assistance centers: "circuit riders" to help with physical connectivity, software, and courseware to expand learning resources and support staff to customize resources and encourage educational innovation and change.

- Support educators' network navigation: simplify user interfaces; develop information directories and libraries of resource materials and instructional enhancements; and publicize pathways to existing and developing knowledge and information resources.

- Build user–communities and sustain them by investing in moderators and teacher–leaders to facilitate discussion, reflection, and mutual growth.

- Design topical and subject–matter groups, and organize on–line conferences and opportunities for collaborative inquiry.

- Elaborate and extend existing reform and restructuring networks electronically to maximize support structures among teachers and across sites.

(4) *Disseminate national standards for curricular excellence, inviting comment, encouraging implementation, and sharing successful practices.*

- Make explicit the expectations for network technology's role in supporting the achievement of the National Education Goals.

- Make clear the education reform agenda, that this system support is for system change and must be standards–based and instructionally driven.

- Communicate standards, and the opportunities to contribute to their development in internetworked communications, early and often.

- Align curriculum standards and assessment practices so that measures of students' learning reflect thoughtful standards–based teaching.

- Encourage subject–matter associations of educators to review developing standards and "certify" appropriate on–line assessment packages.

- Explore the value of on–line exchanges of portfolios of student work –– to develop consistent standards of excellence and to improve assessments through closer attention to inter–rater reliability.

- Encourage frequent electronic exchanges of instructional activity and candid discussion of examples of curricular collaboration.

III. Expand Available Learning Resources to Leverage Educational Excellence.

The currency and immediacy of on–line information is essential to prepare today's learners for tomorrow's world. Students must be assured access to opportunities for meaningful curriculum, instructional engagement, and the responsibility that comes with exploration, analysis, and performance.

Network technology offers an unprecedented array of knowledge resources and learning opportunities. Internetworked computing and communications provide increasing data and information, expanding engagement and interaction, and the potential support for a standards–based curriculum designed to achieve educational excellence for all Americans.

The Task Force has three recommendations for expanding available learning resources to leverage educational excellence. These are outlined and explained below.

(1) *Assure students an education of value through system supports for a standards–based curriculum.*

- Invest in standards development and dissemination, teacher education and related support to improve curricular quality.
- Expand assessment activity to capture students' real work with meaningful material and demand high educational performance.
- Learn how students are learning on–line to enrich and increase their resources, and create more varied and vibrant opportunities for improving instruction.
- Initiate private–sector partnerships for developing the education software needed to disseminate, enhance, and evaluate curricular and instructional practices.

(2) *Consistent with milestones identified by the Federal Coordinating Council on Science and Engineering Technology (FCCSET), establish benchmarks of progress for internetworked communications capacity and activity.*

- Inventory educational technology–based activities (i.e., computational mathematics and science tools, learning environments, teaching aids and tutoring systems, and electronic networking and distance learning).
- Set targets for technology deployment by a date certain (e.g., a computer for every three students and a computer for every teacher for use at home; 30% interconnection of district schools; 20% participation rate for all schools in a technology–based research project, involving working relationships with the scientific community).
- Develop mechanisms for public reporting of progress on benchmark deployment and utilization.

(3) *Make technology-dependent knowledge resources equitably available to all students.*

- States, districts, and schools must address issues of fairness in the scope and sequencing of technology deployment, teacher training, and the learning activities available to students.
- The fundamentally egalitarian environment of internetworked communications must become transparent to learners in order to encourage their access to knowledge and exploration of information environments.
- The vast array of network-based resources will necessarily equalize learning opportunities once the technological connections are assured, so rapid and fair deployment should be construed as an investment in equity and a commitment to education quality.

IV. Forge Strategic Connections Surrounding Schools to Support the Achievement of the National Education Goals.

Engaging opportunities for disciplined discourse and meaningful activity are prerequisites for enriched and continuous learning.

The Task Force has three major recommendations for forging connections surrounding schools to support the achievement of the National Goals. These are outlined and explained below.

(1) *Make the partnership with parents explicit and vivid with the electronic interconnection of households and schools.*

- Use the publics' interests in greater on-line choice and interactivity to obtain the home-school-community connections that will truly support children's learning.
- Take advantage of the immediacy and proximateness of on-line communication to generate and maintain regular parent-teacher dialogue.
- Educate parents electronically about teaching and learning, and students' development and growth.
- Demonstrate to parents the educational uses of technology by helping them learn to use these new tools along with their children.

(2) *Link schools to other public and community resources to both expand learning resources and encourage students' sense of their own lifelong learning opportunities.*

- State policymakers should make sure that state library resources, state agency information, legislative activity, and publicly supported information services -- such as agricultural and home extension services -- are available on the network for school, student, parent, and private-sector access.

- Local governments should use their telecommunications licensing and regulatory authority to make communications services providers responsive to schools; favorable rate structures, high bandwidth and high performance interconnection, technical supports and engineering assistance should be part of performance contracts in the public interest.

- Invite other local resources -- science centers, public access television, and special community groups -- to make electronic interconnections with schools, and facilitate these interactions with incentive structures for information dissemination.

- Use pervasive inter-school connectivity with post-secondary education to re-energize and expand distance learning opportunities to benefit the whole community.

- Create public interest conferences and discussions on-line to elaborate citizen participation and educate students on civic responsibilities.

(3) *Invite the private sector to new forms of partnership with schools.*

- Avoid "gifts" of outmoded or disparate, unconnected telecommunications equipment; instead, request employers' help in deploying real workplace information tools in schools, working together to assure students' technological literacy.

- Because of the lack of network engineers to configure elementary and secondary connectivity, offer private-sector benefactors the opportunity to donate professional services to ensure high quality network engineering in schools and districts.

- Consistent with network privatization activity, schools should explore commercial connections and services providers.
- Electronically link private-sector knowledge resources to the classrooms of the country.
- Create the capacity in schools for serving as test-beds and evaluation sites for educational software and courseware.

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